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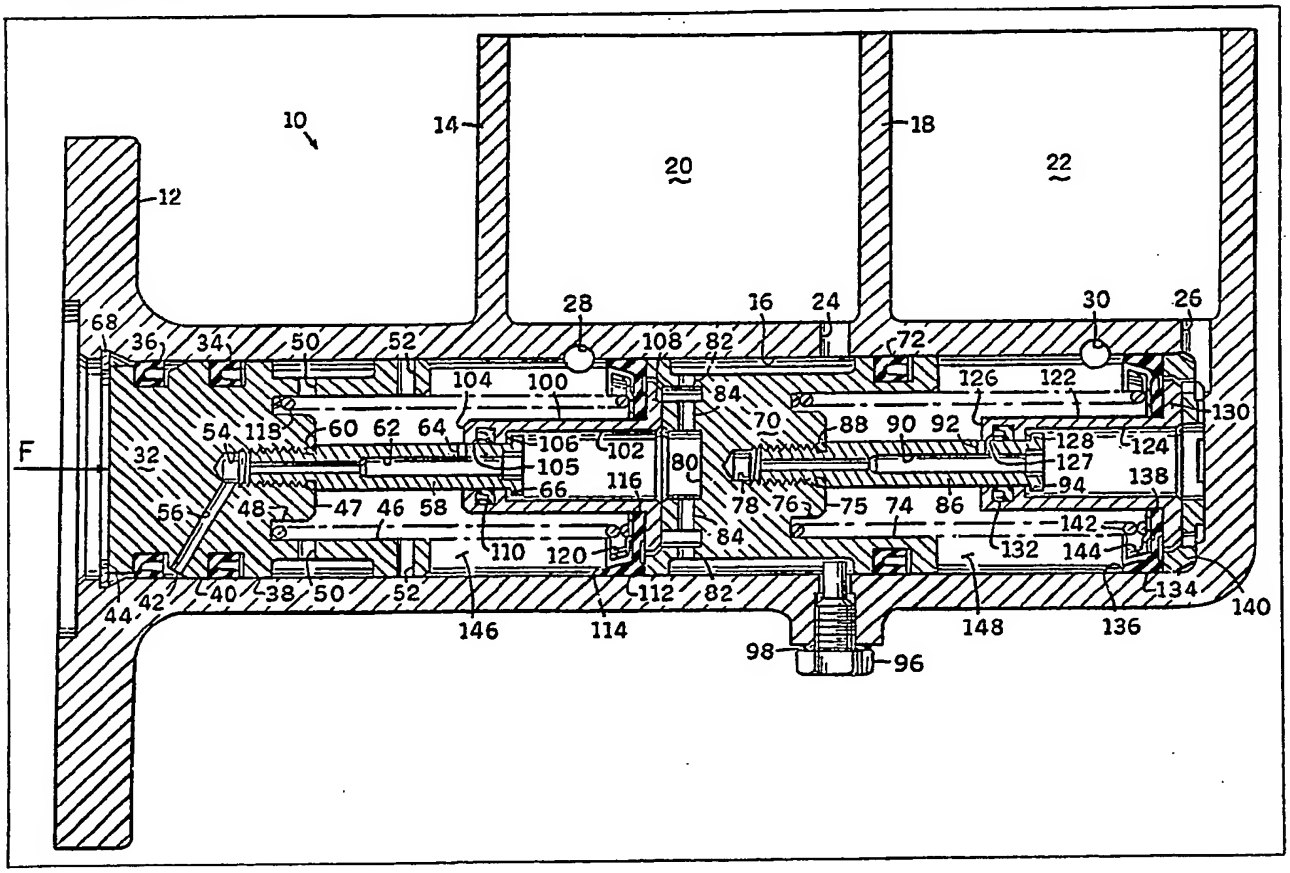
(71) Applicants
Wagner Electric Corporation, 100 Misty Lane, Parsippany, New Jersey 07054, United States of America
(72) Inventor
Edward J. Falk
(74) Agents
G. F. Redfern & Company

# (54) Compact tandem master cylinder

(57) A tandem master cylinder includes a housing having a bore and a fluid reservoir with two separate compartments 20, 22, primary and secondary pistons 32 and 70 are disposed in the bore defining primary 146 and secondary 148 fluid chambers therein, fluid communication between the reservoir compartments and the fluid chambers being via respective portholes 64, 92 formed in stems 58, 86 which are attached to the pistons. The primary piston 32 carries a primary seal 34 and a secondary seal 36 fluid communication between the reservoir compartment 20 and the outer periphery 42 of the primary piston located intermediate the primary and secondary seals being via a passage 56 formed in the primary piston 32.

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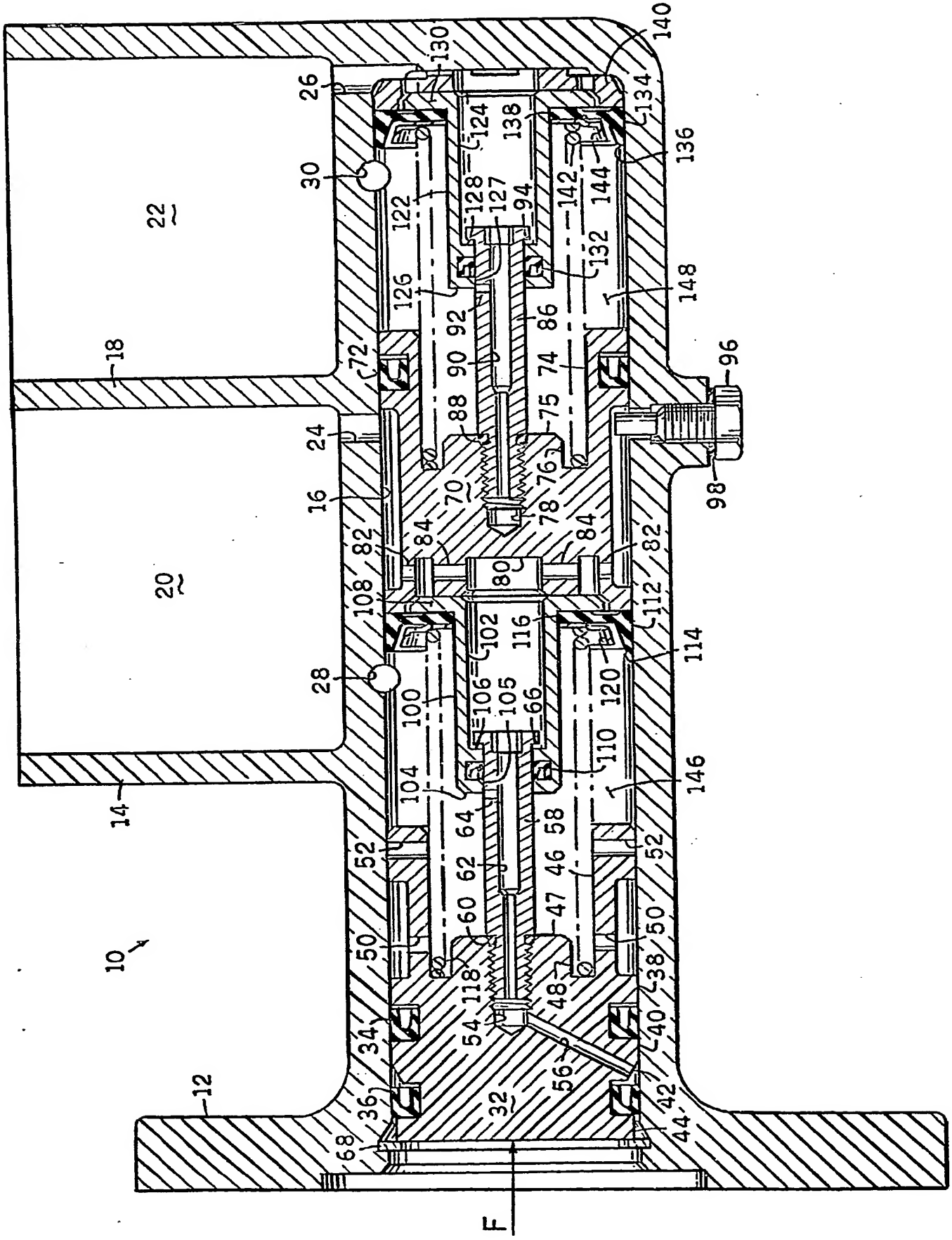
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SPECIFICATION

**Compact tandem master cylinder**

The current trend toward smaller, lighter automotive vehicles has resulted in efforts to reduce the size and weight of many vehicle components. For example, compact tandem master cylinders which are reduced in length and thus weight have been proposed but they have generally necessitated the elimination of the primary piston secondary seal. The conventional type of tandem master cylinder, such as shown in U. S. Patent No. 3,147,596, includes a primary piston assembly carrying a primary pressure seal and a non-pressurized secondary seal. This non-pressurized secondary seal is important because it prevents the external loss of brake fluid from the master cylinder in the event the primary pressure seal should seep or leak. Thus, these compact tandem master cylinders without the primary piston secondary seal are undesirable since they are subject to external loss of brake fluid which could eventually deplete the reservoir resulting in the ingestion of air into the brake system, thereby increasing the potential for brake failure.

It is, therefore, an object of this invention to provide a compact tandem master cylinder which is significantly reduced in length and weight in comparison with the conventional type of tandem master cylinder referred to above, but which retains the primary piston secondary seal.

The tandem master cylinder of the present invention includes a housing having a bore therein, fluid reservoir means having first and second sealingly separated compartments, and primary and secondary piston means disposed in the bore defining primary and secondary fluid chambers therein. The primary and secondary piston means are movable in the bore to establish fluid pressure in the primary and secondary fluid chambers, respectively. The primary piston means includes a stem having port means therein for providing fluid communication between the first reservoir compartment and the primary fluid chamber. The secondary piston means includels a stem having port means therein for providing fluid communication between the second reservoir compartment and the secondary fluid chamber. The primary piston means carries first and second seals spaced apart in its outer periphery for sliding and sealing engagement with the wall of the bore. Passage means in the primary piston means provides fluid communication between the first reservoir compartment and the portion of the outer periphery of the primary piston means located intermediate the first and second seals.

The figure is a cross-sectional side elevation view of a tandem master cylinder embodying the present invention.

The preferred embodiment of the tandem master cylinder of the present invention is generally designated 10 and includes a housing 12 having areservoir 14 and a bore 16. The reservoir 14 is divided by a partition 18 into two separated compartments 20, 22. Ports 24 and 26 are formed in the housing 12 connecting the reservoir compartments 20 and 22, respectively, with the bore 16. Outlet ports 28, 30 are provided in the housing 12 intersecting the bore 16. A cover (not shown) is positioned over the top of the reservoir 14.

A primary piston 32 is movably positioned in the bore 16. The primary piston 32 carries a primary seal 34 and a secondary seal 36 for sliding and sealing engagement with the annular wall of the bore 16. The primary piston 32 has annular surfaces 38, 40, 42, 44 adjacent the primary and secondary seals 34, 36. A cavity 46 is formed in the forward portion of the primary piston 32, and an annular groove 48 is formed in the cavity 46. Passages 50, 52 are provided in the forward portion of the primary piston 32 intersecting the cavity 46. A blind bore 54 extends from the inner end surface 47 of the cavity 46 into the rearward portion of the primary piston 32. A passage 56 is provided in the rearward portion of the primary piston 32 extending between and intersecting the bore 54 and the annular surface 42. A steam 58 has one end threadedly received in the bore 54 so as to be movable with the primary piston 32. A seal 60 is disposed between the stem 58 and the wall of the bore 54. The stem 58 has a passage 62 extending longitudinally therethrough and a porthole 64 extending transversely to and intersecting the passage 62. An annular shoulder 66 is provided at the free end of the stem 58. A snap ring 68 is disposed in a groove in the open end of the bore 16 to limit the leftward movement of the primary piston 32.

A secondary piston 70 is movably positioned in the bore 16. The secondary piston 70 carries a sealing member 72 for sliding and sealing engagement with the annular wall of the bore 16 A cavity 74 is formed in the forward portion of the secondary piston 70, and an annular groove 76 is formed in the cavity 74. A blind bore 78 extends from the inner end surface 75 of the cavity 74 into the rearward portion of the secondary piston 70. A cavity 80 and passages 82, 84 are formed in the rearward portion of the secondary piston 70. A stem 86 has one end threadedly received in the bore 78 so as to be movable with the secondary piston 70. A seal 88 is disposed between the stem 86 and the wall of the bore 78. The stem 86 has a passage 90 extending longitudinally therethrough and a porthole 92 extending transversely to and intersecting the passage 90. An annular shoulder 94 is provided at the free end of the stem 86. A screw 96 is threaded into the bottom of the housing 12 with its end extending into the bore 16 to prevent extreme leftward movement of the secondary piston 70. A seal 98 is disposed between the screw 96 and the housing 12.

A guide member 100 is provided for telescopically receiving the stem 58. The guide member 100 has a central cavity 102, an end wall 104 with a hole 105 therethrough, an annular shoulder 106, and an annular flange 108. The guide member 100 carries a sealing member 110 in sliding and sealing engagement with the outer

peripheral surface of the stem 58. A sealing cup 112 is disposed adjacent the annular flange 108 of the guide member 100. The outer periphery of the sealing cup 112 includes an annular lip 114 for sliding and sealing engagement with the annular wall of the bore 16. The guide member 100 is sealingly received in a central hole 116 in the sealing cup 112. A return spring 118 is caged and compressed between the guide member 100 and the primary piston 32 normally urging the primary piston 32 and the stem 58 leftward in the figure so that the primary piston 32 is in engagement with the snap ring 68 and normally, urging the sealing cup 112 and the guide member 100 rightward in the figure into engagement with the secondary piston 70. One end of the return spring 118 engages a retainer plate 120 which is disposed adjacent the sealing cup 112, and the other end of the return spring 118 seats in the annular groove 48 in the primary piston 32.

A guide member 122 is provided for telescopically receiving the stem 86. The guide member 122 has a central cavity 124, an end wall 126 with a hole 127 therethrough, an annular shoulder 128, and an annular flange 130. The guide member 122 carries a sealing member 132 in sliding and sealing engagement with the outer peripheral surface of the stem 86. A sealing cup 134 is disposed adjacent the annular flange 130 of the guide member 122. The outer periphery of the sealing cup 134 includes an annular lip 136 for sealing engagement with the annular wall of the bore 16. The guide member 122 is sealingly received in a central hole 138 in the sealing cup 134. A back-up plate 140 is disposed in the closed end of the bore 16. A return spring 142 is caged and compressed between the guide member 122 and the secondary piston 70 normally urging the secondary piston 70 and the stem 86 leftward in the figure so that the secondary piston 70 is in engagement with the guide member 100 and normally urging the sealing cup 134 and the guide member 122 rightward in the figure into engagement with the back-up plate 140. One end of the return spring 142 engages a retainer plate 144 which is disposed adjacent the sealing cup 134, and the other end of the return spring 142 seats in the annular groove 76 in the secondary piston 70.

In the tandem master cylinder 10, a primary fluid chamber 146 is formed in the bore 16 between the primary piston 32 and the sealing cup 112, and a secondary fluid chamber 148 is formed in the bore 16 between the secondary piston 70 and the sealing cup 134. When the tandem master cylinder 10 is in the fully released position shown in the figure, there is fluid communication between the reservoir compartment 20 and the primary fluid chamber 146 via the porthole 64 in the stem 58 and there is fluid communication between the reservoir compartment 22 and the secondary fluid chamber 148 via the porthole 92 in the stem 86, thus permitting compensation for expansion and contraction in the volume of the fluid due to temperature changes.

OPERATION

The tandem master cylinder 10 is actuated when a force F is applied to the leftward end of the primary piston 32 moving the primary piston 32 and the stem 58 rightward in the figure. The rightward movement of the stem 58 moves the porthole 64 therein past the sealing member 110 carried by the guide member 100 thereby closing fluid communication between the reservoir compartment 20 and the primary fluid chamber 146. The rightward movement of the primary piston 32 further compresses the spring 118 and establishes fluid pressure in the primary fluid chamber 146 which is delivered through the outlet port 28 to one branch of the dual brake system (not shown). The established fluid pressure in the primary fluid chamber 146 and the force developed by the compressed spring 118 act on the leftward end of the secondary piston 70 causing rightward movement of the secondary piston 70 and the stem 86. The rightward movement of the stem 86 moves the porthole 92 therein past the sealing member 132 carried by the guide member 122 thereby closing fluid communication between the reservoir compartment 22 and the secondary fluid chamber 148 substantially simultaneously with the closing of fluid communication between the reservoir compartment 20 and the primary fluid chamber 146. The rightward movement of the secondary piston 70 establishes fluid pressure in the secondary fluid chamber 148 which is delivered through the outlet port 30 to the other branch of the dual brake system (not shown), substantially simultaneously with the delivery of fluid pressure to the branch of the brake system connected with the outlet port 28. Continued rightward movement of the primary piston 32 builds up fluid pressure in the primary fluid chamber 146 which acts on the secondary piston 70 causing continued rightward movement thereof to build up and maintain substantially equal fluid pressure in the secondary fluid chamber 148.

When the force F is released from the primary piston 32, the return springs 118, 142 move the primary and secondary pistons 32, 70 leftward until the primary piston 32 engages the snap ring 68. The leftward movement of the primary and secondary pistons 32, 70 may form a vacuum in the fluid chambers 146, 148. The pressure differential created by such a vacuum will cause fluid to flow from the reservoir compartments 20, 22 through the intake ports 24, 26 into the bore 16 and past the annular lips 114, 136 of the sealing cups 112, 134 into the fluid chambers 146, 148 to fill any void existing in the fluid chambers 146, 148. When the tandem master cylinder 10 returns to the fully released position shown, fluid communication will be re-established between the reservoir compartments 20, 22 and the fluid chambers 146, 148 via the portholes 64, 92.

In the event of a leak in the branch of the brake

system connected with the outlet port 28, the applied force F moves the primary piston 32 and the stem 58 rightward to further compress the spring 118, but the rightward movement of the primary piston 32 fails to establish fluid pressure in the primary fluid chamber 146. The force developed by the compressed spring 118 moves the secondary piston 70 and the stem 86 rightward to close fluid communication between the reservoir compartment 22 and the secondary fluid chamber 148, as previously described. The applied force F moves the primary piston 32 rightward until the inner end surface 47 of the cavity 46 is in abutment with the end wall 104 of the guide member 100. This abutment between the primary piston 32 and the guide member 100 then causes the applied force F to mechanically drive the secondary piston 70 rightward to establish fluid pressure in the secondary fluid chamber 148 which is delivered through the outlet port 30 to the branch of the brake system connected thereto.

In the event of a leak in the branch of the brake system connected with the outlet port 30, the applied force F moves the primary piston 32 and the stem 58 rightward to further compress the spring 118, to close fluid communication between the reservoir compartment 20 and the primary fluid chamber 146, as previously described, and to establish fluid pressure in the primary fluid chamber 146 which is delivered through the outlet port 28 to the branch of the brake system connected thereto. The established fluid pressure in the primary fluid chamber 146 and the force developed by the compressed spring 118 act on the secondary piston 70 causing rightward movement thereof but, due to the leak, the rightward movement of the secondary piston 70 fails to establish fluid pressure in the secondary fluid chamber 148. Therefore, the secondary piston 70 is moved rightward until the inner end surface 75 of the cavity 74 is in abutment with the end wall 126 of the guide member 122. This abutment between the secondary piston 70 and the guide member 122 prevents further rightward movement of the secondary piston 70 which thereby serves as a fixed rightward end of the primary fluid chamber 146 so that the primary piston 32 will continue to establish fluid pressure in the primary fluid chamber 146.

An important feature of the tandem master cylinder 10 of the present invention is the passage 56 in the rearward portion of the primary piston 32 extending between and intersecting the bore 54 and the annular surface 42. One purpose of the passage 56 is to allow fluid from the reservoir compartment 20 to constantly lubricate the primary piston annular surface 40 thus preventing it from scoring the annular wall of the bore 16 during movement of the primary piston 32. Any such scoring of the bore 16 is undesirable because it may result in damage to the seals 34, 36 and fluid leakage past the seals 34, 36. Fluid leakage past the primary seal 34 could cause brake failure by preventing the primary piston 32 from building up sufficient fluid, pressure in the primary fluid chamber 146 to actuate the brakes. Fluid leakage past the secondary seal 36 could eventually deplete the fluid supply in reservoir compartment 20 resulting in the ingestion of air into the brake system thereby increasing the potential for brake failure. It is apparent that there will be no scoring of the bore 16 by the primary piston annular surfaces 42, 44 since, as seen in the figure, they are not in sliding contact with the annular wall of the bore 16. Another purpose of the passage 56 is to allow any fluid that may seep or leak past the primary seal 34 to return to the reservoir compartment 20.

The present invention provides a compact tandem master cylinder which is significantly reduced in length and weight in comparison with the conventional type of tandem master cylinder such as shown in U. S. Patent No. 3,147,596, but which retains the safety-oriented secondary seal on the primary piston and the safety-proven porthole type of fluid expansion and contraction compensation between the reservoir and the fluid pressure chambers.

It will be understood that the claims are intended to cover all modifications and variations of the preferred embodiment of the invention, herein chosen for the purpose of illustration, without department from the spirit and scope of the invention.

CLAIMS

1. A tandem master cylinder for deliverying fluid pressure to first and second separated branches of a dual brake system comprising:

a) a housing having a bore therein;

b) fluid reservoir means having first and second sealingly separated compartments;

c) primary and secondary piston means disposed in said bore defining primary and secondary fluid chambers in said bore, said primary fluid chamber being in fluid communication with said first branch of said dual brake system, said secondary fluid chamber being in fluid communication with said second branch of said dual brake system;

d) said primary and secondary piston means being movable in said bore for establishing fluid pressure in said primary and secondary fluid chambers, respectively;

e) said primary piston means including a stem having port means therein for providing fluid communication between said first reservoir compartment and said primary fluid chamber; and

f) said secondary piston means including a stem having port means therein for providing fluid communication between said second reservoir compartment and said secondary fluid chamber.

2. The tandem master cylinder defined in claim 1, further comprising:

a) first sealing means positioned for covering the port means in said primary piston means stem in order to close fluid communication between said first reservoir compartment and said primary fluid chamber; and

b) second sealing means positioned for covering the port means in said secondary piston means stem in order to close fluid communication between said second reservoir compartment and said secondary fluid chamber.

3. The tandem master cylinder defined in claim 2, further comprising:

a) first guide means carrying said first sealing means and positioned for telescopically receiving the stem of said primary piston means; and

b) second guide means carrying said second sealing means and positioned for telescopically receiving the stem of said secondary piston means.

4. The tandem master cylinder defined in claims 1 or 3, further comprising:

a) first and second seals carried by said primary piston means spaced apart in the outer periphery thereof for sliding and sealing engagement with the wall of said bore; and

b) passage means in said primary piston means for providing fluid communication between said first reservoir compartment and the portion of the outer periphery of said primary piston means located intermediate said first and second seals.

5. The tandem master cylinder defined in claim 3, wherein:

a) said first guide means is normally urged into engagement with said secondary piston means;

b) said primary piston means abuts said first guide means to mechanically drive said secondary piston means to establish fluid pressure in said secondary fluid chamber upon a failure in said first branch of said dual brake system; and

c) said secondary piston means abuts said second guide means to limit movement of said secondary piston means upon a failure in said second branch of said dual brake system.

6. In a tandem master cylinder of the type including a housing having a bore therein, fluid reservoir means having first and second sealingly separated compartments, primary and secondary piston means disposed in said bore defining primary and secondary fluid chambers in said bore, said primary and secondary piston means being movable in said bore for establishing fluid pressure in said primary and secondary fluid chambers, respectively, the improvement comprising:

a) said primary piston means having port means therein for providing fluid communication between said first reservoir compartment and said primary fluid chamber; and

b) said secondary piston means having port means therein for providing fluid communication between said second reservoir compartment and said secondary fluid chamber.

7. The improvement defined in claim 6, further comprising:

a) first and second seals carried by said primary piston means spaced apart in the outer periphery thereof for sliding and sealing engagement with the wall of said bore; and

b) passage means in said primary piston means for providing fluid communication between said first reservoir compartment and the portion of the outer periphery of said primary piston means located intermediate said first and second seals.

8. A tandem master cylinder substantially as hereinbefore described with reference to, and as illustrated in, the accompanying diagrammatic drawing.

9. Any features of novelty, taken singly or in combination, of the tandem master cylinder as hereinbefore described with reference to the accompanying diagrammatic drawing.

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